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Address delivered by the President, J. C. Adams, Esq. M.A. F.R.S., on presenting the Gold Medal of the Society to Mr. Hind.

Gentlemen,—You have heard from the Report which has just been read how much reason we have to congratulate ourselves on the present state and future prospects of our science. Never was there a time when greater vigour and activity were exhibited in the promotion of it. Nor is this activity confined to one country, or devoted merely to one department of astronomy. Whether we regard the introduction of improved instruments and methods of observation, or the more rigorous discussion to which the observations are submitted, the formation of extensive catalogues of stars, the discovery of new members of our planetary system, or the closer and more systematic scrutiny and examination of those which are already known, in every direction we find the most satisfactory evidences of progress.

One of the most prominent features of astronomical discovery for several years past, has been the continual addition of new members to the remarkable group of small planets between the orbits of *Mars* and *Jupiter*, and the year just ended has been distinguished beyond all precedent in this respect.

Since our last anniversary meeting no fewer than eight of these bodies have been brought to light, and the supply seems to be inexhaustible. New discoverers have made their appearance on the field, while those who have already distinguished themselves seem to have acquired a new aptitude in the search.

It is gratifying to find that one of our own body has been the very foremost in this noble career of discovery; and to him, in testimony of our appreciation of his well-directed and successful labours, the Council has awarded the medal, which it is my pleasing duty this day to present.

Skilfully using the excellent instrumental means placed at his disposal by the enlightened liberality and scientific zeal of Mr. Bishop, and in spite of the interruptions occasioned by a climate, the disadvantages of which are peculiarly felt in researches of this nature, Mr. Hind has added no fewer than eight planets to our system, four of which have been found in the course of the past year. After this, I feel that it is unnecessary to add another word in justification of the award of your medal. Mr. Hind's discoveries are of a nature to be understood and appreciated by all; and I shall, therefore, confine myself to a very brief notice of some circumstances connected with them, and to a few remarks on the conclusions to which they seem to point, respecting the constitution of our planetary system.

The first five of Mr. Hind's planets were found by comparing the heavens with the excellent and well-known star maps of the Berlin Academy. These, however, are limited to 15° on each side of the equator, and, therefore, do not include the whole of the region about the ecliptic, which it is so desirable to examine;

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neither do they contain stars smaller than between the ninth and tenth magnitudes.

Mr. Bishop, therefore, very soon determined to intrust to Mr. Hind the formation of a series of ecliptic charts, which should contain all stars down to the eleventh magnitude, which were situated within 3° on each side of the ecliptic. Mr. Hind has already begun to reap the fruits of these labours, the planet *Fortuna* having been detected in the course of preparing one of the charts, while *Calliope* and *Thalia* were found by the comparison of two of the completed charts with the heavens.

Eight of these valuable charts have now been published, and I understand that most of the remaining ones are considerably advanced. Other astronomers, particularly Mr. Cooper of Markree, are engaged in the preparation of charts on a similar plan, and the path of future discoverers cannot fail to be singularly facilitated by their means.

The existence of such a numerous group of small planets in the same part of our system has naturally given rise to much speculation respecting their origin and mutual relations. When, instead of the single planet which was expected to fill up the gap between the orbits of *Mars* and *Jupiter*, *Ceres* and *Pallas* were found at very nearly the same mean distance from the sun, Olbers threw out the conjecture that they were fragments of a larger planet which had been rent asunder by some internal convulsion, and that many more such fragments probably existed. If this were the case, he reasoned, they would all, after longer or shorter periods, again pass through the point where the explosion took place, and though the perturbations which they would suffer, would, in the course of time, prevent them from continuing to pass exactly through the same point, yet it might be expected that they would not stray far from it, and that, therefore, the remaining fragments might be found by carefully watching the parts of the heavens corresponding to the two points in which the orbits of *Ceres* and *Pallas* approached towards intersecting.

Although the finding of *Juno* and *Vesta* appeared to give some countenance to this hypothesis, later discoveries have deprived it of much of its plausibility. Several of the orbits are everywhere far distant from each other, and where the contrary is the case, the points of nearest approach occur in various parts of the heavens. Probably one reason why Olbers did not discover more of these bodies, though he continued his examination for many years after detecting *Vesta*, was, that he was induced by his theory to confine the search within too narrow limits.

Several astronomers have endeavoured to find some general relations between the orbits of this group, similar to that imagined by Olbers; but it appears to me that they have only succeeded in showing a kind of general resemblance, indicating rather that similar causes have operated in determining the orbits of these bodies than that they were originally identical.

If we allow ourselves to speculate on the formation of our

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planetary system, and adopt the nebular theory, it seems at least as easy to imagine that the nebulous matter, circulating in any particular region about the sun, would, in cooling, collect into many small masses, as that it would all coalesce into one.

Although, as has been stated, there is no single point through which all the orbits nearly pass, yet many of them, taken two and two, approach very closely to each other. In the case of *Astræa* and *Hygeia*, in particular, the shortest distance between the two orbits is less than $\frac{1}{150}$th part of the earth's mean distance from the sun; so that, as M. D'Arrest remarks, the time of their actual intersection cannot be very distant from the present.

One of the most curious circumstances connected with this group is, that there are several cases in which the mean distances are nearly identical with each other. Thus the mean distances of *Ceres* and *Pallas* are so nearly equal, that their order of magnitude is sometimes changed by perturbation. The same remark applies to *Iris* and *Metis*, and also to the three planets, *Astræa*, *Egeria*, and *Irene*.

It should be noticed that this identity of mean distance would not be at all explained by supposing the planets in which it occurs to have been originally one.

There are also some remarkable cases in which the mean motions are nearly commensurable. Thus the mean motions of *Juno* and *Vesta* are very nearly in the ratio of 5 to 6, while those of *Juno* and *Flora* are as 3 to 4, and consequently those of *Vesta* and *Flora* as 9 to 10.*

The extreme smallness of the apparent diameters of these bodies makes it very difficult to determine their real diameters by direct measurement. According to Sir W. Herschel's observations, the diameters of *Ceres* and *Pallas* would not be far from 140 English miles, while Schröter's observations would make them much larger. Stampfer has attempted to determine their diameter by means of their apparent brightness, supposing the reflective power of their surfaces to be the same as that which obtains in the case of *Jupiter*, *Saturn*, *Uranus*, and *Neptune*. This supposition is obviously rather precarious, especially as the reflective power of *Mars* is found to be much less than that of the other planets; but Stampfer's result agrees very closely with the above-mentioned determination of Sir W. Herschel. Several of the more recently-discovered planets appear to be much smaller than these; and it is not improbable that there are many more which, by their excessive minuteness, elude our telescopes altogether. In this point of view, these asteroids would seem to form a connecting link between the larger planets and the aerolites, the cosmical nature of which appears to be pretty well established.

To the physical astronomer these bodies offer problems of great

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* The mean daily sidereal motion of *Juno* is 814″·24; that of *Vesta*, 977″·20; and that of *Flora*, 1086″·08. Also $\frac{6}{5} \times 814{\cdot}24 = 977{\cdot}08$, and $\frac{4}{3} \times 814{\cdot}24 = 1085{\cdot}65$.

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interest and difficulty. On account of the large eccentricities and inclinations of some of the orbits, methods of approximation which succeed in determining the perturbations of the older planets, become quite inadequate to deal with these, and, consequently, astronomers have hitherto been compelled to have recourse to the method of mechanical quadratures in order to calculate their motions. But although this method may be employed in all cases, and the use of it becomes much simplified by applying it directly to the differential equations of motion, in the elegant manner which has been recently devised by Mr. Bond and Professor Encke, yet it only enables us to follow the disturbed planet, as it were, step by step, and it is therefore very desirable to have a method by which the course of the planet might be traced through an indefinite number of revolutions, and the results of which might be embodied in tables.

Professor Hansen has attacked this very difficult problem with his characteristic originality and skill, and Sir J. Lubbock has also treated the same subject very ably in his tracts on the perturbations of the planets. Much, however, remains to be done before the application of the method of quadratures to these cases can be superseded. It will be quite indispensable to take into account the square and higher powers of the disturbing force.

It may be remarked, however, that the eccentricities and inclinations of the orbits of several of these new planets are so moderate, that there will be little difficulty in calculating their perturbations by the ordinary methods.

The disturbances which these bodies suffer from the action of *Jupiter* are so large as to afford an excellent means of determining the mass of that planet. It was thus that Nicolai found that the value of this mass which had been employed by Laplace and Bouvard was considerably too small,—a result which Mr. Airy afterwards confirmed by direct measures of the elongations of the satellites. Considering the great degree of proximity to each other, to which these bodies sometimes attain, it does not seem improbable, notwithstanding their minuteness, that they may occasionally produce a sensible effect on each other's motions, in which case the astronomer would be able to weigh these minute atoms in the same balance which he has already applied to the larger bodies of our system.

In examining the heavens in search of small planets, Mr. Hind has naturally been led to pay great attention to the variable stars, and he has consequently detected a considerable number of these objects among the smaller stars. Two of these I will mention, which are at opposite extremities of the scale, and which seem to imply the operation of totally different causes.

The first is that remarkable new star in *Ophiuchus* which Mr. Hind noticed on the 27th of April, 1848, as being of the 6th magnitude, and occurring in a spot where he was certain no star even of the 9.10th magnitude had been visible three weeks before.

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After attaining to the 4.5th magnitude, so as to be conspicuous to the naked eye, it gradually faded away, and at present it is only of the 11th magnitude.

The other star to which I will refer appears to vary in a similar way to *Algol.* Its period, according to Argelander, is about $9^d\ 11^h\frac{1}{2}$, but for 9 days of this time it shines as a star of the 8th magnitude, then suddenly descends to the 10.11th, and as quickly returns again to the 8th.

Variations of this latter kind appear to be most naturally accounted for by the periodical interposition of an opaque body in its revolution about the star, but those of the kind first-mentioned seem to mock all our attempts at explanation.

In recording these discoveries, it is doubly gratifying to recollect that they emanate from an observatory founded and maintained by a private individual out of pure love of the science and zeal for its advancement. Of the judgment which Mr. Bishop has shown in the selection of his observers, and the choice of objects of observation, there can be no better proof than is afforded by the admirable double-star observations of Mr. Dawes and the planetary discoveries of which we have just been speaking. Mr. Bishop may well feel proud in the consciousness that his observatory has been the means of contributing so largely to science, and has thus become known wherever astronomy is cultivated.

Another subject of congratulation is the manner in which Mr. Hind's services to science have been recognised by the Government of the country. It is sometimes asked, whether the progress of science is best promoted by private or by public means; but the truth is, that there is no such opposition between these modes of advancing it as is implied in the form of the question. In a country where the dignity of science, and the benefits which it confers, are properly estimated, both Government and people will harmoniously co-operate in its support, and each will easily find its appropriate sphere of action. Surely few objects can be mentioned more truly national in their character than the encouragement and reward of scientific discoveries, which at the same time reflect honour on the country, and give so powerful an impulse to the intellectual advancement of the people.

The President then delivering the Medal to Mr. Hind, addressed him in the following terms:—

Mr. Hind,—It is with peculiar pleasure that I present you with this Medal, in testimony of our appreciation of your eminent services to astronomy. The whole world will acknowledge how nobly it has been earned, and will join with us in the wish that your health may long be spared, and that thus you may be able to make many more additions to our knowledge in that field of science to which you have devoted yourself with so much energy and success.